Course title: Energy Simulation Laboratory			
Course code: ENR 107	**No. of credits:** 3	**L-T-P:** 14-0-62	**Learning hours:** 76
Pre-requisite course code and title (if any): NA			
Department: Sustainable Engineering			
Course coordinator: Dr. Ramkishore Singh	**Course instructor:** Dr. Sapan Thapar/ Dr. Ramkishore Singh/ Ms. Nidhi Verma		
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Course type: Core	**Course offered in:** Semester 3		

Course description

Energy software are widely used for policy analysis, scenario evaluation, system design and financial analysis. The availability of cheap computing power has increased both the sophistication and accessibility of these softwares, providing the planning and policy communities with an increasingly broad range of studies, as well as the ability to produce their own assessments. Such assessments offera reasonably transparent and objective foundation for studies of critical energy-related issues, including the need to mitigate global climate change, improve air quality. Each software module covers the basic understanding of the use of the software and exercises focusing on in-depth analysis of variousapplications.

Course objectives

The course is designed to train students on various simulation and analysis software used for design and/oranalysis of renewable energy technologies.

Module	Topic	L	T	P
1	**RET Screen** (i) Design and sizing RET Projects (ii) Greenhouse Gas (GHG) Emission Reduction Analysis (ii) Financial Analysis for various case studies listed below a. **Photovoltaic Project Model** for on-grid (central-grid and micro- grid PV systems); off-grid (stand-alone (PV-battery) and hybrid (PV-battery-genset) systems; and water pumping applications b. **Wind Energy Project Model** for central-grid and micro-grid connected projects, ranging in size from large-scale multi-turbine wind farms to small-scale single-turbine wind-diesel hybrid systems. c. **Small Hydro Project Model** for central-grid and isolated-grid connected projects, ranging in size from multi-turbine small andmini hydro installations to single-turbine micro hydro systems. d. **Solar Water Heating Project Model** for domestic hot water, industrial process heat and swimming pools, ranging in size from small residential systems to large scale commercial, institutional and industrial systems.	2	0	8
2	**PVSyst** (i) Design and simulate grid-connected solar PV power plant for two siteswith different latitudes under fixed tilt, seasonal tilt and tracking. a. Analyse average monthly performance ratio and energy production	2	0	14

	b. Analyse impact of thermal losses for silicon and thin-film technologies c. Analyse total losses for two different locations. d. Plant layout design and electrical outlet design & shading loss analysis (ii) Design and simulate Rooftop PV system for off grid application for ahousehold			
3	**Wind Atlas Analysis and Application Program (WAsP**) (i) Simulate and analyse grid-connected a wind turbine for two sites. (ii) Design and simulate grid-connected wind farm for power generation.	2	0	8
4	**System Advisor Model** (i) Design and simulate solar thermal system for industrial process heatapplication for two sites with different latitudes (ii) Design and simulate different types of concentrator solar thermal powerplants	2	0	8
5	**HOMER** (i) Design and simulate an electrical system for a typical village using morethan two renewable energy sources and technologies	2	0	8
6	**Power System Simulation for Engineering (PSS/E)** (i) Create and simulate a entire system in PSS/E (ii) Determining the voltages, currents, and real and reactive power flowsin a system under a given load conditions (iii) Perform stability analysis in PSS/E	2	0	8
7	**EnergyPlus** (i) Run Pre-Defined Building with no windows (ii) Designing windows (size, material glazing, and position, etc) (iii) Design lighting and air-condition a pre-defined building with windows (iv) Impact of various insulation material	2	0	8
	Total	14	0	62

Evaluation criteria

Test 1: Performance (preparing the simulation and getting results closer to the expected, spread over the entire semester) - 30%
Test 2: Viva-voce (at the end of the semester) - 30%
Test 3: Practical Exam (at the end of the semester) - 20%
Test 4: Practical Records (spread over the entire semester) - 20%

Learning outcomes:

After completing this course students will be able to

- Design of renewable energy power plants by optimum sizing of components (Test 1, 2, 3 and 4)
- Simulate different types of energy systems to evaluate their energy performance (Test 1, 2, 3 and 4)
- Integrate different technologies to create hybrid systems and evaluate their performance (Test 2 and 3)
- Perform financial analysis of different RE technologies (Test 2 and 4)
- Simulate a complete electrical system and carry out power flow analysis (Test 1 and 4)

Pedagogical approach:
Classroom lecture and computational laboratory work

Materials:

Leng, G., Meloche, N., Monarque, A., Painchaud, G., Thevenard, D., Ross, M., & Hosette, P. (2004).Clean Energy Project Analysis: RETScreen Engineering & Cases Textbook-Photovoltaic Project Analysis. *CANMET Energy Technology Center*.

Mermoud, A., & Wittmer, B. (2014). PVSYST user's manual. *Switzerland.*

Mortensen, N. G. (2007). Getting started with WAsP 9. Risø-I-2571 (EN), Risoe National Laboratory,Technical University of Denmark, Roskilde.

Blair, N., Dobos, A., Freeman, J., Neises, T., Wagner, M., Ferguson, T., ... and Janzou, S. (2014). System advisor model, sam 2014.1. 14: General description. *NREL Rep. No. TP-6A20-61019*, *Natl. Renew. EnergyLab. Golden, CO*, *13*.

Energy, H. O. M. E. R. (2011). Getting Started Guide for HOMER Legacy (Version 2.68). *HOMEREnergy: Boulder, Colorado*.

Siemens, P. T. I. (2010). PSS/E User-Manual. *Version 33.4*

U.S. Department of Energy (2017) EnergyPlus Documentation https://energyplus.net/documentation

Additional information (if any): NA

Student responsibilities:
Attendance, feedback, discipline: as per university rules.
Softwares shall be available in the designated laboratory and university would not provide the software foryour personal use.

Course Reviewers

1. Professor S. K. Samdarshi, Centre for Energy Engineering, Central University of Jharkhand, Ranchi
2. Professor Jyotirmay Mathur, Centre for Energy & Environment Malaviya
   National Institute ofTechnology Jaipur